

Indoor Air Exposure Guidelines for Polychlorinated Biphenyls (PCBs) in P.S. 199

This document details the derivation of health-based exposure guidelines for PCBs in indoor air for students attending P.S. 199 in Manhattan and has been developed by the United States Environmental Protection Agency (EPA) Region 2 in consultation with the New York State Department of Health (NYSDOH) and the New York City Department of Health and Mental Hygiene (NYCDOHMH). The exposure guidelines derived in this document are a function of the toxicity of the polychlorinated biphenyl (PCB) congeners and the exposure scenarios that are specific to P.S. 199. A health-based exposure guideline of 0.20 ug/m³ was selected to protect students at P.S. 199 from long-term exposures to PCBs in the indoor air. An appendix to this document demonstrates that it is protective for teachers, administrative staff and custodial workers as well.

Toxicity

Sampling at P.S. 199 has indicated the presence of Aroclors 1248 and 1254. PCBs exhibit both carcinogenic and non-carcinogenic health effects. EPA's Integrated Risk Information System (IRIS) contains toxicity factors for both the cancer and the non-cancer health effects of various PCBs. Toxicity factors for non-carcinogenic effects are specific to particular Aroclors and for route of exposure. For carcinogenic effects, toxicity factors are categorized according to risk and persistence (i.e., high risk/persistence, low risk/persistence and lowest risk/persistence). For non-carcinogenic effects, the IRIS data base has quantitative toxicity assessments for two Aroclors (1016 and 1254) by the oral route of exposure. Inhalation toxicity factors for PCBs (Reference Concentrations [RfC]) are not available on IRIS. The IRIS data base has quantitative oral cancer potency values (Slope Factors) for the three aforementioned PCB risk/persistence categories. Inhalation specific cancer potency factors (Inhalation Unit Risk [IUR]) are not directly available on IRIS (see discussion below). An inquiry to EPA's Superfund Technical Support Center was made to check the status of Provisional Peer Reviewed Toxicity Values (PPRTVs). Inhalation PPRTVs for PCBs are not available for either non-cancer or cancer endpoints (USEPA 2009). In the absence of a route specific (i.e., inhalation) toxicity factors for PCBs, the toxicity factors (oral

Exposure Scenarios

Toxicity factors are combined with exposure scenarios to calculate health-based exposure guidelines. The New York City Department of Health and Mental Hygiene provided information on the occupancy patterns for students and workers at P.S. 199. The school serves grades kindergarten through 5th grade (Ages: 5 years to 11 years). Additional exposure parameters are listed below.

- School year: 180 days

- School day: 6:5 hours (8:30 am to 2:50 pm) for majority of children

- Extended school day: Some students stay until 3:40 pm for tutoring 3 days a week; a few children arrive at 8 am for breakfast; some children stay for after school activities;

the longest day for any given child is 10 hours from 8 am to 6 pm

- No weekend programs

- No summer programs that use the school except that some will use the cafeteria as a gathering spot before an activity (very brief)

Upper-bound and central tendency exposure parameters for students are listed below.

Exposure Parameters (Student)

ET	10 hrs/day (upper bound estimate)	6.5 hrs/day (central tendency)
EF	180 days/year (upper bound estimate)	180 days/yr (central tendency)
ED	6 yrs (upper bound estimate)	6 yrs (central tendency)

Where:

ET (hours/day) = exposure time;

EF (days/year) = exposure frequency;

ED (years) = exposure duration; and

Relative Source Contribution (RSC)

Where:

IUR ($\mu\text{g}/\text{m}^3$)⁻¹ = Inhalation Unit Risk; and
EC ($\mu\text{g}/\text{m}^3$) = exposure concentration

$$EC = (CA \times ET \times EF \times ED)/AT$$

Where:

EC ($\mu\text{g}/\text{m}^3$) = exposure concentration;

CA ($\mu\text{g}/\text{m}^3$) = contaminant concentration in air;

ET (hours/day) = exposure time;

EF (days/year) = exposure frequency;

ED (years) = exposure duration; and

AT (lifetime in years) (70) x 365 days/year x 24 hours/day = averaging time

$$CA = CR/IUR \times AT / (ET \times EF \times ED)$$

CA = 1.0 $\mu\text{g}/\text{m}^3$ (exposure guideline for upper-bound exposure assumptions)

CA = 1.4 $\mu\text{g}/\text{m}^3$ (exposure guideline for central tendency exposure assumptions)

Non-Cancer Hazard Assessment:

RfC = 0.05 $\mu\text{g}/\text{m}^3$

Hazard Quotient (HQ) = EC/RfC

Target Hazard Quotient = 1

Relative Source Contribution = 0.8

$$EC = (CA \times ET \times EF \times ED)/AT$$

Where:

EC ($\mu\text{g}/\text{m}^3$) = exposure concentration;

CA ($\mu\text{g}/\text{m}^3$) = contaminant concentration in air;

diets high in fish, from PCB-contaminated waters, can significantly increase an individual's dietary intake of PCBs (ATSDR, 2000). An 80% RSC may also account for nominal background PCB exposures unrelated to diet.

Chronic exposure to PCBs has been associated with both carcinogenic and non-carcinogenic effects. EPA's IRIS data base provides toxicity factors to evaluate the risk/hazard associated with chronic exposure to PCBs. EPA has cancer potency factors (oral Slope Factors and derived Inhalation Unit Risks) for three tiers of PCBs based on persistence. The Slope Factor is the result of application of a low-dose extrapolation procedure and is presented as the risk per (mg/kg)/day. The Inhalation Unit Risk is the quantitative estimate in terms of risk per $\mu\text{g}/\text{m}^3$ air breathed. PCBs are classified by IRIS as a probable human carcinogens based on cancer bioassays in animals but inadequate data in humans. A 1996 study found liver tumors in female rats exposed to Aroclors 1260, 1254, 1242, and 1016, and in male rats exposed to 1260. These mixtures contain overlapping groups of congeners that, together, span the range of congeners most often found in environmental mixtures. Earlier studies found high, statistically significant incidences of liver tumors in rats ingesting Aroclor 1260 The IRIS cancer assessment provides both upper-bound and central tendency Slope Factors and Inhalation Unit Risks. In this assessment, the most potent cancer value (upper-bound Inhalation Unit Risk for high persistence congeners) was employed. This is consistent with the recommendation in the IRIS file to use the high persistence tier for all early life exposure. The high persistence tier is also recommended for inhalation exposure to dust or aerosols. All exposure guidelines derived in this document based on the carcinogenic endpoint are less stringent than the most stringent guideline ($0.2 \mu\text{g}/\text{m}^3$ – upper bound exposed students) based on a non-carcinogenic endpoint. Therefore, protecting against non-cancer health effects would insure that all exposure populations would incur less than a one-in-one-hundred thousand excess lifetime cancer risk above background from indoor exposure to PCBs at P.S. 199. As noted earlier (see discussion on relative source contribution), background exposure to PCBs in the environment is relatively small and getting smaller, therefore cancer risk from background exposure to PCBs in the environment would be similarly minimal.

The EPA IRIS data base contains oral Reference Doses (RfDs) for Aroclors 1254 and 1016. The Aroclor 1254 RfD is more than a factor of three more stringent than the Aroclor 1016 RfD. The oral Reference Dose (RfD) is based on the assumption that

it is relevant to note that dermal and ocular effects, including skin irritation, chloracne, hyperpigmentation and eyelid and conjunctival irritation, have been observed in humans occupationally exposed to Aroclor 1254 and other Aroclor formulations.

As previously noted, a route-to-route extrapolation was made to convert the Aroclor 1254 RfD to an RfC (for adults) by accounting for body weight (70 kg) and ventilation rate (20m³/day) as per the approach recommended in the Risk Assessment Guidance for Superfund (1989). A similar exercise was performed using age-appropriate body weight and ventilation rate (USEPA, 2008) for students. This simplified process does not account for pharmacokinetic differences between the exposure pathways or for portal of entry effects. However, the IRIS file on PCBs endorses route-to-route extrapolation of the oral Slope Factor to an Inhalation Unit Risk (IUR). The IRIS file details the similar high absorption by both the oral and inhalation route, the common metabolic pathway by both routes and the lack of portal of entry effects as factors supporting an inter-route extrapolation. Accordingly, this same rationale supports the route-to-route extrapolation of the Aroclor 1254 RfD to an RfC.

The student body is not the only group occupying P.S. 199 on a routine basis. Teachers, administrative staff and custodial workers are also subject to PCB exposure. The Appendix of this report contains exposure guidelines for this collective group of adults working at P.S. 199. Occupational regulations may supersede the exposure guidelines derived for worker populations. However, the recommended exposure guideline developed for students (see below) would be sufficiently protective of adult workers as well.

The exposure assumptions detailed in this report are intended to reflect both upper-bound and central tendency exposure scenarios. It should be noted that inhalation exposure is most proximally related to ventilation rate (the amount of air exchange per unit time). In this assessment, exposure time (hrs/day) is employed as a surrogate for ventilation rate. This approach is deemed acceptable as the ventilation rate for both students and teachers is not expected to differ significantly between the time spent in school and out of school over the course of a day. To the extent that custodial workers may engage in more vigorous activity than teachers over the course of a workshift, it is acknowledged that the use of exposure time as a surrogate for ventilation rate may underestimate, to an unquantifiable but likely modest degree, the actual exposure to this worker population.

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Appendix

Exposure Parameters (Teacher/Administrative Staff)

The New York City Department of Health and Mental Hygiene reports that teachers at
P.S. 199 work a calendar year of approximately 185 days. As previously noted, there are
no summer programs. It was further reported that teachers may occasionally work up to
10 hours a day. The EPA Exposure Factors Handbook (EPA 1997) lists 405 minutes
(approximately 7 hours) as the 50 percentile for time in school by full time employees.

ET 10 hrs/day (upper-bound estimate) 7 hrs/day (central tendency)

default factors from EPA references (EPA 1997, EPA 1991) were employed along with best professional judgment to estimate upper-bound and central tendency values.

ET	9.5 hrs/day (upper-bound estimate)	7 hrs/day (central tendency)
EF	208 days/year (upper-bound estimate)	185 days/yr (central tendency)
ED	25 yrs (upper-bound estimate)	7 yrs (central tendency)

Cancer Risk

Target Risk 1 E-05

Inhalation Unit Risk = 5.7 E-04 per ug/m³

$$CA = CR/UR \times AT/ (ET \times EF \times ED)$$

CA = 0.22 ug/m³ (exposure guideline for upper-bound exposure assumptions)

CA = 1.2 ug/m³ (exposure guideline for central tendency exposure assumptions)

Non Cancer Hazard

Target Hazard Quotient = 1

RfC = 0.07 ug/m³

RSC = 0.8

$$CA = HQ \times RfC \times RSC \times AT/ (ET \times EF \times ED)$$

CA = 0.21 ug/m³ (exposure guideline for upper-bound exposure assumptions)

CA = 0.38 ug/m³ (exposure guideline for central tendency exposure assumptions)